MEMORANDUM

SUBJECT: Analysis of Socio-Economic Factors for Populations Living Near Petroleum Refineries

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This document describes the approach used to evaluate the cancer risks sustained by different social, demographic and economic groups within the populations living near petroleum refineries associated with inhalation exposures to hazardous air pollutants (HAP) emitted by the refineries. It also presents the results of that analysis and contrasts it with the estimated distribution of inhalation cancer risks associated with all sources of HAP in the vicinity of those refineries. This work was carried out in support of the U.S. Environmental Protection Agency's Residual Risk and Technology Review (RTR) for petroleum refinery emissions subject to Maximum Available Control Technology (MACT) requirements under 40 CFR 63 Subpart CC. This review encompasses all petroleum refinery emission sources except catalytic cracking units, catalytic reforming units, sulfur units, and associated bypass lines.

In the RTR analysis, risks due to the inhalation of HAP were modeled for the populations residing within 50 kilometers of each petroleum refinery using the Human Exposure Model, Version 3 (HEM3).[1] HEM3 estimates cancer and noncancer risks at the level of census blocks using the AERMOD state-of-the-art air dispersion model developed under the direction of the American Meteorological Society (AMS) / EPA Regulatory Model Improvement Committee (AERMIC). Each census block typically includes about 50 people. Additional information on the risk analysis is available on the RTR webpage (http://www.epa.gov/ttn/atw/rrisk/residriskpg.html), which provides a report for the petroleum refining emission category, covering the inputs and specific assumptions, and addressing uncertainties specific to the category.

In the current analysis, cancer risk predictions from the petroleum refining HEM3 modeling effort were linked to detailed census data in order to evaluate the distribution of risks for different social, demographic and economic groups. The following population categories were studied:

- Total population
- White
- African American (or Black)
- Native Americans
- Other races and multiracial
- Hispanic or Latino

- Children 18 years of age and under
- Adults 19 to 64 years of age
- Adults 65 years of age and over
- Adults without a high school diploma
- Households earning under the national median income
- People living below the poverty line

The HEM3 results for a particular census block reflect the level of risk that would be experienced by an individual residing in the block for 70 years. In addition, the HEM3 risk estimates are not adjusted for commuting patterns or for the difference between indoor and outdoor pollutant concentrations.

Risk estimates from petroleum refining emissions were compared to the overall inhalation risks and exposures experienced by the same population (i.e., all the people living within 50 km of any petroleum refinery). In addition, the distributions of cancer risks due to inhalation are presented for the above population categories in the nation as a whole. The overall inhalation risks were obtained from the draft National-scale Air Toxics Assessment (NATA) for 2002, which estimates the risks associated with HAP emissions from all stationary sources, onroad and nonroad mobile sources, dispersed area sources, and the background due to long-range transport and natural emissions.[2]

Census Data

Table 1 summarizes the census data used in this analysis, showing the source of each dataset and the level of geographic resolution. All of the data are from the 2000 Decennial census. Race and ethnicity data were obtained at the census block level. Age distributions, data on educational status, and economic data were obtained at the block group level. A census block contains about 50 people on average; and a block group contains about 26 blocks on average, or about 1,350 people. (For comparison, a census tract is larger than a block group, with each tract containing an average of 3 block groups, or about 4,300 people.)

Table 1. Summary of Census Data used to Analyze Risks for Different Socio-economic Groups

Type of population category	Source of data	Level of geographic resolution
Racial and ethnic categories	Landview®	Census block
Age groups	SF3 Table P8	Block group
Level of education - adults without a high school diploma	SF3 Table 37	Block group
Households earning below the national median income	SF3 Table 52	Block group
People living below the poverty line	SF3 Table P87	Block group

Data on race and ethnicity were obtained primarily from the Landview® database compiled by the Census Department.[3] Landview® gives a breakdown for the population of each census block among different racial classifications, including: White, African American or Black, American Indian or Native Alaskan, Asian, Native Hawaiian or other South Pacific Islander, other race, and two or more races. In the current analysis, the Asian, Native Hawaiian or other South Pacific Islander, and other race categories were combined into a single category. The Landview® database also indicates the number of people in each tract that are of Hispanic or Latino ethnicity. Landview® covers the 50 states, the District of Columbia, and Puerto Rico, but does not cover the Virgin Islands. Race and ethnicity data on the Virgin Islands were obtained from the Virgin Islands Summary File.[4]

Data on age distributions, poverty status, household incomes, and education level in the U.S. and Puerto Rico were obtained from the 2000 Census of Population and Housing Summary File 3 (SF3) Long Form. For the U.S. this file was accessed on a DVD version prepared by GeoLytics.[5] SF3 data for Puerto Rico were obtained from the Census Department website,[6] and data for the Virgin Islands were retrieved from similar tables in the Virgin Islands Summary File.[4]

The SF3 data set consists of over 800 separate tables, each providing information on a different subject. For the current analysis, data were obtained from Tables P8, P37, P52, and P87. Table P8 gives the estimated numbers of men and women in different age categories for each census block group. Table P37 analyzes the level of education attained by men and women over 25 years of age (e.g. some high school but no high school diploma, high school graduate, some college, etc.). Table P52 gives information on household income in 1999, and Table P87 estimates the number of people living below the poverty line in each block group.

Calculation Methods

HEM3 models the cancer risk at a point near the geographic center of each census block.[1] For the current analysis, this risk estimate was assumed to apply to all individuals residing in the block. We used block identification codes to link the HEM3 modeling results for each block to the appropriate census statistics. This allowed us to estimate the numbers of people falling into different population subcategories within each block. We then analyzed the distribution of estimated inhalation risks within each population subcategory, giving the numbers of people within the subcategory that are exposed to different risk levels. Each distribution involved a tabulation of all of the census blocks modeled for the petroleum refining category. We also computed the average risk for all individuals in each population subcategory.

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[1] HEM3 generally uses the coordinates given by the census for the internal point, or "centroid" of each block. However, when the footprint of an industrial facility includes the block centroid, the model is designed to identify the highest-risk point outside of the facility's footprint.

Distributions of risk and average risks were computed for the raw HEM3 model results for petroleum refineries. For comparison, distributions of risk and average risks were computed for all NATA emissions in the geographic regions affected by petroleum refinery emissions (i.e., for all people living within 50 km of a petroleum refinery), and in the country as a whole.

The calculation method used for categories where block-level data were available are described below.

Racial and Ethnic Categories and the Total Population

Since race and ethnicity data were available at the census block level, the calculation of risk distributions for these categories involved a simple block-by-block accumulation of the people in each subcategory. We began by identifying a set of bins reflecting the level of risk. The population of each block was then assigned to the appropriate risk bin based on the modeled risk level in the block. The numbers of people in each risk bin were then added together for all of the blocks modeled for the petroleum refining category:

$$H(R_{ab},s) = \sum_i^{(Ra \le Ri < Rb)} [N(s,i)] \quad (1)$$

where:

$H(R_{ab},s)$ = the population count for risk bin R_{ab}, which is between R_a and R_b for population subgroup "s"

R_i = the modeled risk level in block "i" (estimated lifetime cases of cancer per million population)

$\sum_i^{(Ra \le Ri < Rb)}$ refers to the summation over all blocks i where R_i falls in bin R_{ab}, between R_a and R_b

$N(s,i)$ = the number of people within population subcategory s, in block i

The same approach was used for the total population. The average risk for a given population subcategory or for the total population was calculated using the following equation:

$$A(S) = \sum_i [N(s,i) \times R_i] / \sum_i [N(s,i)] \quad (2)$$

where:

$A(s)$ = the average risk for population subgroup "s" (estimated lifetime cases of cancer per million population)

$\sum_i$ refers to the summation over all blocks "i" modeled for the emission source category

$N(s,i)$ and R_i were defined above

It must be noted that in the overall NATA risk analysis, only stationary sources were modeled at the census block level. Risks due to onroad and nonroad mobile emissions sources, dispersed area sources, and ambient background levels of HAP were analyzed at the census tract level instead of the block level. EPA chose this larger scale of analysis for these categories for two reasons. First, the locations of these sources are not known definitively. Rather, the geographic distribution of emissions for these categories has been estimated from

county level emissions data. Second, emissions from these categories are believed to be more uniformly distributed within a given county or census tract. Therefore, in the current analysis, we have assumed that the NATA risks for mobile sources, area sources, and background pollutant levels are the same for all blocks within a given census tract. As noted above, stationary source risk estimates were available at the census block level.

Age Categories

Age data were retrieved from the Table P8 of the census SF3 Table, which contains data on the numbers of males and females of different ages in each census block group. In processing the age data, we began by aggregating the categories in the census to the broader age groups studied in this analysis. For instance, the total number of children 18 years of age and under was calculated by adding together the number of girls under 1 year, the number of boys under 1 year, the number of 1-year-old girls, the number of 1-year-old, and so on up to and including 18-year-old girls. In this way, we calculated the number of children age 18 and under, the number of adults from 18 to 64, and the number of adults 65 and older in each census block group.

The next step was to estimate the numbers of people in each age group at the block level. To make this calculation, we assumed that the fraction of people in each age group was the same for all blocks in a given block group. Thus, the number of people in a particular age group and within a particular census block was estimated as follows:

$$N(a,b/bg) = N(t,b/bg) \times N(a,bg) / N(t,bg) \quad (3)$$

where:

N(a,b/bg) = number of people within age group “a”, in block “b” of block group “bg”
N(t,b/bg) = total number of people in block “b” of block group “bg”
N(a,bg) = number of people within age group “a” in block group “bg”
N(t,bg) = total number of people in block group “bg”

Equation 1 was then applied to the block-level population estimates to generate risk distributions for different age groups, and Equation 2 was used to compute the average risk for each age group.

Level of Education

Table P37 of the SF3 dataset specifies the education status for men and women age 25 and older for each census block group, based on the last grade completed. To obtain the total number of adults without a high school degree, we added together the numbers who had completed grades below a high school senior. Thus, the number of people without a high school degree equals the sum of the number of males with no schooling, the number of females with no schooling, the numbers of males and females who have completed nursery school through 4th grade, up to the numbers of males and females who have completed some high school but not received a high school degree.

The number of adults without a high school degree as a fraction of the total population was assumed to be the same for each block in the block group. Thus, the number of adults without a high school degree in each block was computed as follows:

$$N(nhs,b/bg) = N(t,b/bg) \times N(nhs,bg) / N(t,bg) \quad (4)$$

where:

$N(nhs,b/bg)$ = number of adults without a high school diploma, in block "b" of block group "bg"
$N(t,b/bg)$ = total number of people in block "b" of block group "bg"
$N(nhs,bg)$ = number of adults without a high school diploma in block group "bg"
$N(t,bg)$ = total number of people in block group "bg"

Equation 1 was then used to generate risk distributions based on the block-level results, and Equation 2 was used to compute the average risk for adults without a high school diploma.

Household Income

Table P52 of the SF3 dataset estimates the numbers of households in each block group with income for the year 1999 in various ranges, generally divided into $5000 increments (e.g. $10,000 to $14,999, $15,000 to $19,999, etc.). The median national income for 1999 was about $42,000 per year. Therefore, in order to determine the number of households with incomes under the median income, we added the estimates for the ranges below that level. We assumed that the household incomes in the $40,000 to $44,999 increment were evenly distributed over this range. Therefore, 40% of the households in the $40,000 to $49,000 income range were assumed to be below the national median income of about $42,000. The following equation was used to estimate the fraction of households below the national median income within each census block group:

$$F(sm,bg) = [C_{<10} + C_{10\text{-}15} + \ldots. + C_{35\text{-}40} + (0.4 \times C_{40\text{-}45})] / C_T \quad (5)$$

where:

$F(sm,bg)$ = fraction of households in block group "bg" with incomes below the median national income
$C_{<10}$ = number of households with incomes under $10,000
$C_{10\text{-}15}$ = number of households with incomes from $10,000 to $14,999
$C_{35\text{-}40}$ = number of households with incomes from $35,000 to $39,999
$C_{40\text{-}45}$ = number of households with incomes from $40,000 to $44,999
C_T = total number of households in block group "bg"

The fraction of people living in households below the median income for each block within the block group was assumed to the same as the fraction of households below the median income for the block group.

$$N(sm,b/bg) = F(sm,bg) \times N(t,b/bg) \quad (6)$$

where:

N(sm,b/bg) = number of people in block "b" of block group "bg" living in households below the national median income

F(sm,bg) = fraction of households in block group "bg" below the national median income

N(t,b/bg) = total number of people in block "b" of block group "bg"

Equation 1 was then used to generate risk distributions based on the block-level results, and Equation 2 was used to compute the average risk for adults without a high school diploma. It must be noted that this approach neglects any potential relationship between household size and income level within a particular block group. However, it is expected to provide a reasonable indication of the risk level of people living below the national median income, relative to the population as a whole.

Poverty Level

Table P87 of the SF3 dataset estimates the total number people in each block group living below the poverty level, as well as the numbers of people below the poverty level in different age groups. The current study did not include an analysis of poverty status by age group, only of the total population below the poverty line. The fraction of people below the poverty line was assumed to be the same for each block in the block group. Thus, the population below the poverty line in each block was computed as follows:

$$N(p,b/bg) = N(T,b/bg) \times N(p,bg) / N(T,bg) \quad (7)$$

where:

N(p,b/bg) = number of people below the poverty line in block "b" of block group "bg"

N(T,b/bg) = total number of people in block "b" of block group "bg"

N(p,bg) = number of people below the poverty line in block group "bg"

N(T,bg) = total number of people in block group "bg"

Equation 1 was then used to generate risk distributions based on the block-level results, and Equation 2 was used to compute the average risk for adults without a high school diploma.

Results

Table 2 shows the distribution of estimated lifetime inhalation cancer risks for different racial and ethnic groups among the population living near petroleum refineries (within 50 km). Distributions of risk are shown for different age groups in Table 3; and for adults with and without a high school diploma in Table 4. Finally, Table 5 shows the estimated distribution of risk for people living in households below the national median income, and for people living below the poverty line. For comparison, each of the tables also gives the distributions of total inhalation risks for the population living near petroleum refineries, and for the nation as a whole. The overall inhalation risks were obtained from the

draft NATA for 2002, which estimates the risks associated with HAP emissions from all stationary sources, onroad and nonroad mobile sources, dispersed area sources, and the background due to long-range transport and natural emissions.

It must be noted that the estimated inhalation risks presented in Tables 2 through 5 reflect the level of risk that would be experienced by an individual residing in the block for 70 years. In addition, the HEM3 risk estimates are not adjusted for commuting patterns or for the difference between indoor and outdoor pollutant concentrations.

Table 2 shows that the average risk levels from petroleum refining emissions for African Americans and Hispanic or Latino Americans are 0.049 in a million and 0.051 in a million, respectively. These values are about 33% higher than the average risk from petroleum refining emissions for the general population, estimated at 0.037 in a million. Table 2 also shows that the risks from petroleum refinery emissions make up a relatively small fraction, less than 0.1%, of the total estimated inhalation risks for the population living near petroleum refineries. Overall inhalation cancer risks for African Americans and Hispanic Americans and living near petroleum refineries are estimated at 54 in a million and 59 in a million, respectively. These values are 5% and 14% higher than the average overall inhalation cancer risk for people living near refineries, estimated at about 51 in a million. In the nation as a whole, the estimated overall inhalation cancer risks for African Americans and Hispanic Americans are about 14% and 21% higher than the population as a whole (50 and 52 in a million, respectively, for African Americans and Hispanic Americans, compared with 43 in a million for the population as a whole).

Table 3 shows that the average risk from petroleum refinery emissions for children under 18 is estimated at 0.040 in a million, or about 9% higher than average risk for the population as a whole (estimated at 0.037 in a million). The average risk from refinery emissions for adults without a high school education is estimated at 0.048 in a million (Table 4), about 37% higher than the average risk for all adults over 25 (estimated at 0.035 in a million).

Table 6 shows that the estimated average risk levels from petroleum refining emissions for people living in households below the national median income and people living under the poverty line are 0.045 in a million and 0.050 in a million, respectively. These values are about 21% and 35% higher, respectively, than the average risk from petroleum refining emissions for the general population (0.037 in a million). The overall inhalation cancer risk for people living below the poverty line near petroleum refineries is estimated at 56 in a million. This is about 9% higher than the average overall inhalation cancer risk for people living near refineries, estimated at about 51 in a million. In the nation as a whole, the estimated overall inhalation cancer risks for people living below the poverty line is about 7% higher than the population as a whole (46 in a million compared with 43 in a million).

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[1]. EC/R. 2006. Modeling for the Residual Risk and Technology Review Using the Human Exposure Model 3 – AERMOD Version. Prepared by EC/R Incorporated for the U.S. Environmental Protection Agency, Research Triangle Park, NC.

[2]. EPA. 2008. National Air Toxics Assessments. U.S. Environmental Protection Agency, Research Triangle Park, NC. http://www.epa.gov/ttn/atw/natamain/

[3]. Census. 2002. LandView 5 on DVD [electronic resource] : a viewer for EPA, Census and USGS data and maps. U.S. Census Bureau, Washington, D.C.

[4]. Census. 2008. Virgin Islands Summary File. U.S. Census Bureau, Washington, D.C. www.factfinder.census.gov

[5]. Census. 2004. Census DVD 2000 Long Form SF3, Release 2.2. Geolytics, Inc., East Brunswick, NJ. www.geolytics.com

[6]. Census. 2008. SF3 Data for Puerto Rico. U.S. Census Bureau, Washington, D.C. www.factfinder.census.gov

Table 2. Distribution of Inhalation Cancer Risk for Racial and Ethnic Groups

Range of lifetime individual cancer risk (chance in one million)[a]	Numbers of people in different ranges for lifetime cancer risk[b]					
	Total population	White	African American	Native American	Other and multiracial	Hispanic or Latino[c]
Modeled risk from the petroleum refining category						
0 to 1	90,115,366	58,765,282	14,372,424	620,336	16,357,324	17,741,066
1 to 5	403,286	224,169	81,317	3,314	94,486	154,151
5 to 10	16,878	11,188	3,226	178	2,286	4,160
10 to 20	2,898	1,539	489	107	763	1,320
20 to 30	209	74	3	8	124	192
Total number	90,538,637	59,002,252	14,457,459	623,943	16,454,983	17,900,889
Average risk (chances in one	0.037	0.034	0.049	0.039	0.039	0.051
Overall modeled NATA risk in the census blocks affected by the category						
10 to 20	1,965,034	1,581,578	191,844	80,371	111,241	200,085
20 to 30	9,444,565	7,459,066	769,019	102,300	1,114,180	1,334,710
30 to 40	18,857,331	14,612,149	2,192,946	102,430	1,949,806	2,325,452
40 to 50	22,340,829	14,958,641	4,107,942	105,342	3,168,904	3,394,147
50 to 100	34,580,068	18,236,605	6,847,026	210,563	9,285,874	9,830,992
100 to 150	2,579,818	1,621,507	280,939	16,398	660,974	676,568
150 to 200	633,035	446,785	52,224	5,650	128,376	102,700
200 to 250	121,272	73,795	13,958	804	32,715	34,818
250 to 300	13,943	10,549	830	79	2,485	1,239
300 and over	2,742	1,577	731	6	428	178
Total number	90,538,637	59,002,252	14,457,459	623,943	16,454,983	17,900,889
Average risk (chances in one	51	49	54	47	60	59
Overall modeled NATA risk nationwide						
1 to 5	5	5	0	0	0	0
10 to 20	25,070,631	21,075,093	1,915,699	791,434	1,288,405	1,674,054
20 to 30	56,371,772	47,926,248	4,332,087	540,866	3,572,571	5,492,109
30 to 40	64,107,797	52,295,944	5,972,943	386,763	5,452,147	6,972,029
40 to 50	59,329,931	44,124,835	8,059,686	285,460	6,859,950	7,780,692
50 to 100	74,169,254	45,268,667	13,943,081	434,761	14,522,745	15,439,486
100 to 150	4,828,596	2,854,966	635,926	38,550	1,299,154	1,453,802
150 to 200	990,773	682,700	107,801	8,755	191,517	175,533
200 to 250	275,454	177,342	40,190	1,906	56,016	64,065
250 to 300	77,305	58,485	9,318	417	9,085	14,547
300 and	117,610	75,518	27,142	603	14,347	17,443
Total number	285,339,128	214,539,803	35,043,873	2,489,515	33,265,937	39,083,760
Average risk (chances in one	43	41	50	35	54	52

Notes:

[a]Modeled risks are for a 70-year lifetime, based on the predicted outdoor concentration and not adjusted for exposure factors.

[b]Distributions by race are based on demographic information at the census block level. Risks from petroleum refinery emissions were modeled at the block level, as were other NATA stationary source emissions. Mobile sources, area sources, and background risks were analyzed at the census block level

[c]The Hispanic or Latino population is double-counted in this analysis, since different individuals within the category may classify themselves as White, African American, Native American, or other.

Table 3. Distribution of Risk for Different Age Groups

Range of lifetime individual cancer risk (chance in one million)[a]	Numbers of people in different ranges for lifetime cancer risk[b]			
	Total population	Ages 0 thru 18	Ages 19 thru 64	Ages 65 and up
petroleum refining category				
0 to 1	90,115,366	24,755,447	55,188,243	10,171,675
1 to 5	403,286	130,659	231,063	41,564
5 to 10	16,878	5,333	9,858	1,686
10 to 20	2,898	1,040	1,613	246
20 to 30	209	84	109	16
Total number	90,538,637	24,892,563	55,430,887	10,215,187
Average risk (chances in one million)	0.037	0.040	0.036	0.035
Overall modeled NATA risk in the Census blocks affected by the category				
10 to 20	1,965,034	563,832	1,143,951	257,251
20 to 30	9,444,565	2,741,425	5,644,695	1,058,445
30 to 40	18,857,331	5,379,073	11,447,633	2,030,626
40 to 50	22,340,829	6,120,875	13,558,998	2,660,956
50 to 100	34,580,068	9,356,886	21,393,332	3,829,850
100 to 150	2,579,818	565,447	1,725,501	288,870
150 to 200	633,035	143,741	416,174	73,120
200 to 250	121,272	18,350	87,713	15,209
250 to 300	13,943	2,608	10,521	814
300 and over	2,742	325	2,369	47
Total number	90,538,637	24,892,563	55,430,887	10,215,187
Average risk (chances in one million)	51	50	52	51
Overall modeled NATA risk nationwide				
1 to 5	5	0	5	0
10 to 20	25,070,631	6,894,902	14,505,096	3,670,634
20 to 30	56,371,772	15,435,120	33,580,881	7,355,771
30 to 40	64,107,797	17,743,411	38,724,903	7,639,483
40 to 50	59,329,931	15,891,012	36,109,528	7,329,391
50 to 100	74,169,254	19,740,544	45,640,146	8,788,564
100 to 150	4,828,596	1,200,030	3,103,953	524,612
150 to 200	990,773	233,245	637,125	120,403
200 to 250	275,454	56,815	182,771	35,868
250 to 300	77,305	18,745	47,824	10,737
300 and over	117,610	31,540	70,259	15,811
Total number	285,339,128	77,245,364	172,602,490	35,491,274
Average risk (chances in one million)	43	43	44	42

Notes:

[a]Modeled risks are for a 70-year lifetime, based on the predicted outdoor concentration

[b]Distributions by age and education level are based on modeling data at the Census block level, and age and education data at the block group level. All blocks in a block group are assumed to have the same age and income distribution.

Table 4. Distribution of Risk for Adults with and without a High School Diploma

Range of lifetime individual cancer risk (chance in one million)[a]	Numbers of people in different ranges for lifetime cancer risk[b]		
	Total population	Total number 25 and older	Number 25 and older without a high school diploma
Modeled risk from the			
0 to 1	90,115,366	57,905,278	11,959,325
1 to 5	403,286	234,946	85,122
5 to 10	16,878	10,095	2,974
10 to 20	2,898	1,627	766
20 to 30	209	105	74
Total number	90,538,637	58,152,051	27,772,917
Average risk (chances in one million)	0.037	0.035	0.048
Overall modeled NATA risk in the Census blocks affected by the category			
10 to 20	1,965,034	1,263,403	314,863
20 to 30	9,444,565	5,995,800	1,144,527
30 to 40	18,857,331	12,026,607	1,812,589
40 to 50	22,340,829	14,432,975	2,591,587
50 to 100	34,580,068	22,124,709	5,700,371
100 to 150	2,579,818	1,772,467	383,312
150 to 200	633,035	432,853	81,308
200 to 250	121,272	90,982	18,982
250 to 300	13,943	10,313	447
300 and over	2,742	1,942	276
Total number	90,538,637	58,152,051	12,048,261
Average risk (chances in one million)	51	52	55
Overall modeled NATA risk nationwide			
1 to 5	5	3	0
10 to 20	25,070,631	16,482,661	3,988,492
20 to 30	56,371,772	36,572,360	7,654,547
30 to 40	64,107,797	41,300,671	6,667,178
40 to 50	59,329,931	38,540,993	6,458,901
50 to 100	74,169,254	47,678,464	10,852,986
100 to 150	4,828,596	3,140,410	825,547
150 to 200	990,773	668,029	139,675
200 to 250	275,454	189,348	44,498
250 to 300	77,305	52,790	9,921
300 and over	117,610	76,265	18,720
Total number	285,339,128	263,470,769	27,772,917
Average risk (chances in one million)	43	43	45

Notes:

[a]Modeled risks are for a 70-year lifetime, based on the predicted outdoor concentration and not adjusted for exposure factors.

[b]Distributions by age and education level are based on modeling data at the Census block level, and age and education data at the block group level. All blocks in a block group are assumed to have the same age and income distribution.

Table 5. Distribution of Risk for People Living in Households below the National Median Income and Below the Poverty Line

Range of lifetime individual cancer risk (chance in one million)[a]	Numbers of people in different ranges for lifetime cancer risk[b]: Total population	People living in households below the national median income[c]	People living below the poverty line
Modeled risk from the petroleum refining category			
0 to 1	90,115,366	42,559,199	12,544,294
1 to 5	403,286	259,941	89,241
5 to 10	16,878	10,287	3,296
10 to 20	2,898	2,056	750
20 to 30	209	152	62
Total number	90,538,637	42,831,635	12,637,642
Average risk (chances in one million)	0.037	0.045	0.050
Overall modeled NATA risk in the Census blocks affected by the category			
10 to 20	1,965,034	1,210,505	334,305
20 to 30	9,444,565	4,604,518	1,214,835
30 to 40	18,857,331	7,767,109	1,888,189
40 to 50	22,340,829	9,814,941	2,649,943
50 to 100	34,580,068	17,719,062	5,948,039
100 to 150	2,579,818	1,315,297	472,571
150 to 200	633,035	331,343	102,006
200 to 250	121,272	63,529	26,100
250 to 300	13,943	4,261	1,026
300 and over	2,742	1,070	630
Total number	90,538,637	42,831,635	12,637,642
Average risk (chances in one million)	51	53	56
Overall modeled NATA risk nationwide			
1 to 5	5	0	0
10 to 20	25,070,631	15,491,205	3,800,519
20 to 30	56,371,772	30,063,647	7,248,109
30 to 40	64,107,797	28,637,423	6,709,286
40 to 50	59,329,931	26,298,007	6,588,608
50 to 100	74,169,254	37,588,507	11,575,942
100 to 150	4,828,596	2,691,968	994,691
150 to 200	990,773	543,766	169,431
200 to 250	275,454	162,389	60,405
250 to 300	77,305	43,066	11,655
300 and over	117,610	70,847	22,382
Total number	285,339,128	141,590,823	37,181,029
Average risk (chances in one million)	43	43	46

Notes:

[a]Modeled risks are for a 70-year lifetime, based on the predicted outdoor concentration and not adjusted for exposure factors.

[b]Distributions by income are based on modeling data at the Census block level, and income data at the block group level. All blocks in a block group are assumed to have the same age and income distribution.

[c]The median income is the national median household income in 1999, about $41,000.